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Abstract Forty cases of hermatypic scleractinian corals colonizing molluscan shells were recorded. Forty-five colonies of the corals belonging to eight genera in six families grew on 40 shells belonging to 15 genera in 12 families. Forty colonies were found in Tanabe Bay and its vicinity, southwestern Kii Peninsula, Japan, and 10 colonies in coral reef regions in Okinawa, Palau and probably the Banda Sea and/or the Arafura Sea. Usually one colony, rarely two to four colonies of at least two species of corals, grew on a shell of three families of gastropods and nine families of bivalves. Although the shell surface is a suitable substratum for planula larvae to settle down, coral colonies can not grow to large sizes on the shells. In most cases, shells may not be stable and sufficient substrata for continuous growth of corals. However, the corals on the shells may conduct the sexual reproduction to some extent. Unstability of molluscan shells as footholds may be one of the reasons why the association is not remarkable on the reefs.

Key words: hermatypic scleractinian corals, molluscan shells, Tanabe Bay, coral reef regions, settlement substrata, unstable footholds.

Introduction

Hermatypic scleractinian corals are usually found to colonize rocky substrata and the skeletons of dead corals, and sometimes concrete architectures and wrecks. They are also found even on roots of mangroves (Veron, 1986) and a variety of drifting things (Jokiel, 1984, 1990, 1992). There are, however, very few records of the corals growing on molluscan shells. In Japanese waters, there are only two such records for a hermatypic coral (Nishihira & Veron, 1995; Nishihira, 1997). Recently we encountered many cases of this association in the rocky reef regions of the Japanese temperate zone. The same association was also noticed in the southern coral reef regions of the subtropical and tropical zones. In this paper, we report all cases we found out including deposited specimens, and discuss the relationships between the corals and the molluscs.

Records

In every case, records are described in the text in the following order.

- The combination of the molluscan species (class, order, family) and the scleractinian coral species (family).
- Collection data: date; site; methods.
- Remarks.

Other information shown in Table 1 are alive or dead when the specimens were found;

in corals, estimated living area (%) in the whole surface of the colony, and the greatest length of the colony × the length perpendicular to the greatest length, and estimated coverage (%) of the basal part of a coral colony to the area of the shell surface except the shell base in gastropods; in molluscs, dimensions such as the shell diameter, the shell height and the shell length.

In molluscs, the higher classification is basically referred to Ponder & Lindberg (1996) and species are mainly identified according to Kubo & Kurozumi (1995). In corals, species identification is referred to Veron & Pichon (1976, 1980, 1982), Veron et al. (1977), Veron & Wallace (1984), Veron (1986) and Nishihira & Veron (1995).

I. Specimens from Tanabe Bay and its vicinity

From 1995 to 1998, 34 specimens of gastropods and bivalves colonized by nine identified and four unidentified species of corals were collected from Tanabe Bay and its vicinity (33°41′–44′N, 135°20′–22′E, Fig. 1), southwestern Kii Peninsula, Japan. In this region, 77 species of hermatypic corals have been recorded on the rocky reef substrate (Veron, 1992; Nishihira & Veron, 1995).

In many cases that the shells were dead and empty when found, it is uncertain whether the coral larvae settled on the shells when the molluscs were alive.

1. *Tectus* (*Tectus*) *pyramis* (Born, 1778) (Gastropoda, Vetigastropoda, Trochidae) - *Acropora ?dendrum* (Bassett-Smith, 1890) (Acroporidae) (Pl.XII, Fig. 1)
· January 30, 1998. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip

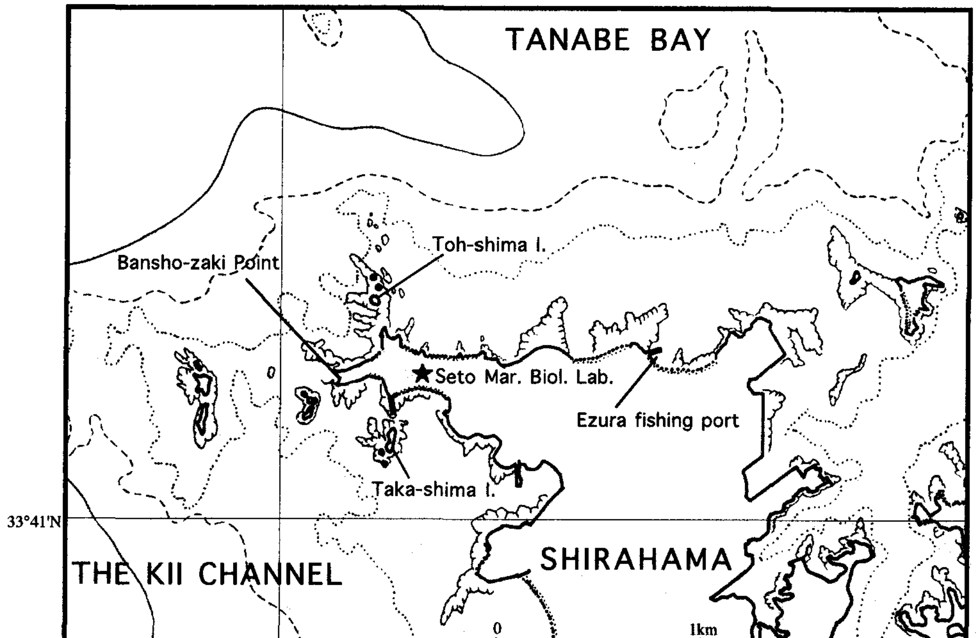

Fig. 1. A map of southern part of Tanabe Bay.

Table 1. Molluscs and colonizing corals on their shells.

Case[1]	Locality	Molluscs		Corals			
		Species	Size (mm)[2]	Species	Size (mm)[3]	Living area (%)[4]	Coverage to the shell surface (%)[5]
1	Tanabe Bay	*Tectus* (*Tectus*) *pyramis**	60.3 (SD)	*Acropora ?dendrum*	47.0 × 41.9	100	70
2	Tanabe Bay	*Trochus maculatus**	32.1 (SD), 30.0 (SH)	*Pocillopora damicornis*	17.9 × 16.3	100	10
3	Tanabe Bay	*Angaria neglecta*	–	*Acropora dendrum*	86.9 × 71.0	100	100
4	Tanabe Bay	*A. neglecta*	–	*Acropora solitaryensis*	112.9 × 97.8	100	100
5	Tanabe Bay	*Astralium* (*Astralium*) *haematragum*	30.1 (SD)	*Acropora hyacinthus*	90.4 × 43.9	40	100
6	Tanabe Bay	*A.* (*A.*) *haematragum*	26.6 (SD)	*A. hyacinthus*	50.3 × 50.0	70	100
7	Tanabe Bay	*A.* (*A.*) *haematragum**	–	*Acropora valida*	50.1 × 40.3	100	100
8	Tanabe Bay	*Crepidula* (*Bostricapulus*) *grasvispinosus*	24.9 (SL)	*Psammocora superficials*	36.4 × 31.8	50	100
9	Tanabe Bay	*C.* (*B.*) *grasvispinosus*	21.3 (SL)	*Cyphastrea* sp.	34.0 × 27.2	0	90
10	Tanabe Bay	*Barbatia* (*Abarbatia*) *lima**	17.1 (SH, l), 31.2 (SL, l)	*Cyphastrea serailia*	35.9 × 22.9	100	10(l), 95(r)
11	Tanabe Bay	*Hormomya mutabilis*	29.7 (LAPA, r)	*Pocillopora damicornis*	82.5 × 74.8	100	70(l), 10(r)
12	Tanabe Bay	*H. mutabilis*	32.4 (LAPA, l)	*Acropora dendrum*	54.1 × 41.4	100	30(l), 95(r)
13	Tanabe Bay	*H. mutabilis*	–	*Acropora hyacinthus*	73.4 × 61.2	100	70(l), 70(r)
14	Tanabe Bay	*H. mutabilis*	–	*A. hyacinthus*	90.9 × 71.8	100	60(l), 60(r)
15	Tanabe Bay	*H. mutabilis**	–	*A. hyacinthus*	27.0 × 24.2	95	65(l), 40(r)
16	Tanabe Bay	*H. mutabilis*	–	*A. ?hyacinthus*	50.2 × 43.8	100	70(l), 75(r)
17	Tanabe Bay	*H. mutabilis*	–	*Acropora solitaryensis*	72.0 × 61.3	100	100(l), 100(r)
18	Tanabe Bay	*H. mutabilis*	–	*A. solitaryensis*	59.6 × 50.6	100	70(l), 80(r)
19	Tanabe Bay	*H. mutabilis*	–	*A. ?solitaryensis*	52.1 × 42.7	80	80(l), 100(r)
20	Tanabe Bay	*H. mutabilis*	27.8 (LAPA, l)	*A. ?solitaryensis*	37.9 × 34.9	95	60(l), 45(r)
21	Tanabe Bay	*H. mutabilis*	–	*Acropora* sp.	41.1 × 26.6	100	70(l), 85(r)
22	Tanabe Bay	*H. mutabilis**	23.5 (LAPA, l)	*Acropora* sp.	18.9 × 14.1	100	0(l), 60(r)
23	Tanabe Bay	*H. mutabilis*	–	*Cyphastrea serailia*	36.1 × 22.6	95	70(l), 80(r)
24	Tanabe Bay	*H. mutabilis**	28.6 (LAPA, l)	*C. serailia*	33.1 × 19.0	100	70(l), 20(r)

Table 1. (continued)

Case[1]	Locality	Molluscs		Corals			
		Species	Size (mm)[2]	Species	Size (mm)[3]	Living area (%)[4]	Coverage to the shell surface (%)[5]
25	Tanabe Bay	*Pinna (Cryptopinna) bicolor**	404.9 (LAPA, l)	*Acropora* sp.	55.2 × 40.2	100	<5(l)
26	Tanabe Bay	*Pinctada margaritifera**	76.7(SH, l), 73.0(SL, l)	*Pocillopora damicornis*	14.4 × 12.2	100	<5(l)
27	Tanabe Bay	*Spondylus (Spondylus) candidus**	85.4(SH, l), 81.6(SL, l)	*Acropora solitaryensis*	117.2 × 103.0	100	50(l)
28	Tanabe Bay	*Spondylus (Spondylus)* sp. (fragment)	–	*Montipora* sp.	51.0 × 35.8	0	100
29	Tanabe Bay	*Parahyotissa imbricata**	79.4(SH, r), 56.5(SL, r)	*Porites* sp.	16.6 × 11.6	100	<5(r)
30	Tanabe Bay	*Dendostrea crenulifera**	40.1(SH, r), 54.5(SL, l)	*Porites* sp.	28.8 × 12.0	80	20(l)
31	Tanabe Bay	*D. crenulifera*	48.9(SH, r), 38.3(SL, r)	*Montastrea valenciennesi*	34.6 × 31.7	100	<5(l), 40(r)
32	Tanabe Bay	*Chama (Chama) brassica**	51.1(SH, r), 65.3(SL, r)	*Acropora dendrum*	44.3 × 40.5	70	40(r)
33	Tanabe Bay	*C. (C.) brassica*	52.8(SH, r), 41.0(SL, r)	*Acropora solitaryensis*	147.7 × 122.8	100	100(r)
34	Tanabe Bay	*C. (C.) brassica**	57.2(SH, r), 54.6(SL, r)	*Psammocora profundacella*	83.6 × 73.8	100	100(r)
35	Okinawa	*Tridacna (Flodacna) maxima*	104.0(SH, l), 206.6(SL, l)	*Porites* spp.	31.0 × 20.5, 21.9 × 17.3	0	<5 (two colonies, l)
36	Palau	*Turbo (Lunatica) marmoratus*	172.8(SH), 192.8(SD)	*Porites* sp.	8.2 × 7.0	?	<1
37	tropical sea	*Tectus (Rochia) niloticus*	100.8(SH), 127.2(SD)	*Pocillopora verrucosa*	59.2 × 53.9	?	<5
				Porites spp.	22.7 × 10.5, 13.5 × 11.8, 11.8 × 8.9	? ? ?	<5 (three colonies)
38	tropical sea	*T. (R.) niloticus*	135.1(SH), 139.1(SD)	*Acropora* sp.	84.9 × 65.8	?	15
39	tropical sea	*T. (R.) niloticus*	103.0(SH), 112.3(SD)	*Acropora* sp.	81.0 × 42.0	?	15
40	tropical sea	*Pinctada maxima*	186.3(SH, l), 183.5(SL, l)	*Turbinaria peltata*	117.0 × 105.9	?	10

1): No. in the text, 2): SD=shell diameter; SH=shell height; SL=shell length; LAPA=length of antero-posterior axis, 3): the greatest length of the colony × the length perpendicular to the greatest length, 4): estimated living area in the whole surface of the colony, 5): estimated coverage of the basal part of the colony to the shell surface. *: alive when found. –: unmeasurable. l,r: measurements in left valve (l) and right one (r).

net from a boat).

· It is likely that this specimen had been trapped and tangled in a robster gill net at deeper habitat and carried to the jetty, where it was removed and thrown into the sea. According to a fisherman, the net was set around the rocky reefs off Bansho-zaki Point (10–20 m deep)(Fig. 1). Both the shell and the coral were still alive when found.

2. *Trochus maculatus* Linnaeus, 1758 (Gastropoda, Vetigastropoda, Trochidae) - *Pocillopora damicornis* (Linnaeus, 1758) (Pocilloporidae) (Pl. XII, Fig. 2)

· July 9, 1998. Near Toh-shima I., 1 m deep (skin diving).

· The shell was found crawling on a rock. The coral was wholly alive.

3. *Angaria neglecta* Poppe & Goto, 1993 (Gastropoda, Vetigastropoda, Turbinidae) - *Acropora dendrum* (Acroporidae) (Pl. XII, Figs. 3a & 3b)

· January 21, 1998. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip net from a boat).

· This specimen seems to have been caught by a lobster gill net around Bansho-zaki Point as mentioned in the case 1. The shell was empty but the coral was wholly alive.

4. *Angaria neglecta* - *Acropora solitaryensis* Veron & Wallace, 1984 (Acroporidae) (Pl. XII, Figs. 4a & 4b)

· January 21, 1997. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip net from a boat).

· This specimen seems to have been caught by a lobster gill net around Bansho-zaki Point as mentioned in the case 1. The shell was dwelled by a hermit crab, *Dardanus crassimanus* (H. Milene Edwards, 1836) and the coral was wholly alive.

5. *Astralium* (*Astralium*) *haematragum* (Menke, 1829) (Gastropoda, Vetigastropoda, Turbinidae) - *Acropora hyacinthus* (Dana, 1846) (Acroporidae) (Pl. XII, Fig. 5)

· May 12, 1998. Near Taka-shima I. (Fig. 1), 8 m deep (SCUBA diving).

· The specimen was found lying on the gravelly bottom near a rocky wall. The shell was empty but the coral was partially alive.

6. *Astralium* (*Astralium*) *haematragum* - *Acropora hyacinthus* (Pl. XII, Fig. 6)

· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 6 m deep (SCUBA diving).

· The specimen was found lying on the sandy bottom among rocks. The shell was empty but the coral was partially alive.

7. *Astralium* (*Astralium*) *haematragum* - *Acropora valida* (Dana, 1846) (Acroporidae) (Pl. XII, Fig. 7)

· July 10, 1995. In a tide pool at the north coast of Bansho-zaki Point (Fig. 1) (hand collection).

· Both the shell and the coral were alive when found. It was kept in a tank set at the sunny place with circulation water until December 28, 1995 when the coral colony was entirely bleached.

8. *Crepidula* (*Bostricapulus*) *grasvispinosus* Kuroda & Habe, 1950 (Gastropoda, Neotaenioglossa, Crepidulidae) - *Psammocora superficialis* Gardiner, 1898 (Siderastreidae) (Pl. XII, Figs. 8a & 8b)

· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 6 m deep (SCUBA diving).

· The specimen was found on the sandy bottom among rocks. The shell was dead but the coral was partially alive. The coral colony extends up to 9.6 mm outwards from the edge of the shell.

9. *Crepidula* (*Bostricapulus*) *grasvispinosus* - *Cyphastrea* sp. (Faviidae) (Pl. XII, Fig. 9)
· July 28, 1997. On the beach at the western coast of Bansho-zaki Point (Fig. 1), stranded.
· Both the shell and the coral were dead. The costae of the coral is indistinct because the surface of the colony was worn away. The colony extends up to 8.1 mm outwards from the edge of the shell except the semi-circular concavity (about 10 mm in diameter) whose bottom attains to the shell surface with a small hall (about 2 mm in diameter) penetrating the shell in the center of the concavity (Plate XII, Fig. 9, arrow). Since this hole seems to have been bored by an unidentified carnivorous gastropod when the shell was alive, it is most likely that the coral larva settled on the living shell.

10. *Barbatia* (*Abarbatia*) *lima* (Reeve, 1844) (Bivalvia, Arcoida, Arcidae) - *Cyphastrea serailia* (Forskål, 1775) (Faviidae) (Pl. XIII, Fig. 1)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The living shell attached to a narrow crevice with byssal threads. The coral was wholly alive.

11. *Hormomya mutabilis* (Gould, 1861) (Bivalvia, Mytiloida, Mytilidae) - *Pocillopora damicornis* (Pl. XIII, Fig. 2)
· May 26, 1998. Off the northwest of Toh-shima I. (Fig. 1), 4 m deep (SCUBA diving).
· The empty shell was found embedded among living shells in a *Hormomya* bed, and was easily pulled off from the bed because of the absence of byssal threads. The coral was wholly alive.

12. *Hormomya mutabilis* - *Acropora dendrum* (Pl. XIII, Fig. 3)
· March 4, 1998. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip net from a boat).
· This specimen seems to have been caught in a lobster gill net around Bansho-zaki Point as mentioned in the case 1. The shell was empty but the coral was wholly alive.

13. *Hormomya mutabilis* - *Acropora hyacinthus* (Pl. XIII, Fig. 4)
· May 14, 1998. Off the northeast of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was wholly alive.

14. *Hormomya mutabilis* - *Acropora hyacinthus* (Pl. XIII, Fig. 5)
· May 20, 1998. Off the north of the laboratory (Fig. 1), 3 m deep (SCUBA diving).
· The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was wholly alive.

15. *Hormomya mutabilis* - *Acropora hyacinthus* (Pl. XIII, Fig. 6)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The living shell was found attaching firmly to a rock with byssal threads in a *Hormomya* bed. The coral was partially dead.

16. *Hormomya mutabilis* - *Acropora ?hyacinthus* (Pl. XIII, Fig. 7)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).

· The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was wholly alive.

17. *Hormomya mutabilis* - *Acropora solitaryensis* (Pl. XIII, Fig. 8)
· May 14, 1998. Off the northeast of Toh-shima I. (Fig. 1), 6 m deep (SCUBA diving).
· The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was wholly alive and covered the whole shell except a slit (3.3 mm × 1.9 mm) corresponding to an interstice between two valves.

18. *Hormomya mutabilis* - *Acropora solitaryensis* (Pl. XIII, Fig. 9)
· May 14, 1998. Off the northeast of Toh-shima I. (Fig. 1), 6 m deep (SCUBA diving).
· The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was wholly alive.

19. *Hormomya mutabilis* - *Acropora ?solitaryensis* (Pl. XIII, Fig. 10)
· May 14, 1998. Off the northeast of Toh-shima I. (Fig. 1), 6 m deep (SCUBA diving).
· The specimen was found lying on the gravelly bottom near a rocky reef. The shell was empty and the coral was partially dead in the part touching the bottom.

20. *Hormomya mutabilis* - *Acropora ?solitaryensis* (Pl. XIII, Fig. 11)
· May 20, 1998. Off the north of the laboratory (Fig. 1), 2 m deep (SCUBA diving).
The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was partially dead.

21. *Hormomya mutabilis* - *Acropora* sp. (Pl. XIII, Fig. 12)
· May 12, 1998. Near Taka-shima I. (Fig. 1), 7 m deep (SCUBA diving).
· The empty shell was found in a *Hormomya* bed as mentioned in the case 11. The coral was wholly alive.

22. *Hormomya mutabilis* - *Acropora* sp. (Pl. XIV, Fig. 1)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The living shell was found attaching firmly to a rock with byssal threads in a *Hormomya* bed. The coral was wholly alive.

23. *Hormomya mutabilis* - *Cyphastrea serailia* (Pl. XIV, Fig. 2)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The specimen was found lying on a rocky flat. The shell was empty and the coral was partially dead.

24. *Hormomya mutabilis* - *Cyphastrea serailia* (Pl. XIV, Fig. 3)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The living shell was found attaching firmly to a rock with byssal threads in a *Hormomya* bed. The coral was wholly alive.

25. *Pinna* (*Cryptopinna*) *bicolor* Gmelin, 1791 (Bivalvia, Mytiloida, Pinnidae) - *Acropora* sp. (Pl. XIV, Fig. 4)
· July 2, 1995. Off the north of the laboratory (Fig. 1), 6 m deep (SCUBA diving).
· The living shell was buried 18 cm deep in the sand, and the coral found on the left valve ranged 26.2–31.7 cm from the umbo, or 8 cm above the bottom surface. The coral

was wholly alive.

26. *Pinctada margaritifera* (Linnaeus, 1758) (Bivalvia, Pterioida, Pteriidae) - *Pocillopora damicornis* (Pl. XIV, Fig. 5)
· May 21, 1998. Off the southwest of Toh-shima I. (Fig. 1), 3 m deep (SCUBA diving).
· The living shell was found attaching to a rock with byssal threads. The coral was wholly alive.

27. *Spondylus* (*Spondylus*) *candidus* Lamarck, 1819 (Bivalvia, Pterioida, Spondylidae) - *Acropora solitaryensis* (Pl. XIV, Fig. 6)
· December 11, 1995. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip net).
· This specimen seems to have been caught in a lobster gill net around Bansho-zaki Point as mentioned in the case 1. Both the shell and the coral were alive when found.

28. *Spondylus* (*Spondylus*) sp. (fragment) - *Montipora* sp. (Acroporidae) (Pl. XIV, Fig. 7)
· April 9, 1998. On the north beach of the laboratory (Fig. 1), stranded.
· The surface of the dead coral, extending up to 9.3 mm outwards from the margin of the shell fragment, was worn away but calices were well remained all over the surface. Therefore, it is most likely that the coral larva settled and grew on the fragment.

29. *Parahyotissa imbricata* (Lamarck, 1819) (Bivalvia, Pterioida, Pycnodonteidae) - *Porites* sp. (Poritidae) (Pl. XIV, Fig. 8)
· May 14, 1998. Off the northeast of Toh-shima I. (Fig. 1), 5 m deep (SCUBA diving).
· The living shell was found attaching to a rock. The coral was wholly alive.

30. *Dendostrea crenulifera* (Sowerby, 1871) (Bivalvia, Pterioida, Ostreidae) - *Porites* sp. (two colonies) (Pl. XIV, Fig. 9)
· May 14, 1998. Off the northeast of Toh-shima I. (Fig. 1), 6 m deep (SCUBA diving).
· The living shell was found attaching to a rock with the umbonal part of the left valve. The coral was partially dead.

31. *Dendostrea crenulifera* - *Montastrea valenciennesi* (Edwards & Haime, 1848) (Faviidae) (Pl. XIV, Fig. 10)
· July 8, 1998. Off the north of the laboratory (Fig. 1), 2 m deep (skin diving).
· The empty shell was found attaching to a rock with the left valve. The coral was wholly alive.

32. *Chama* (*Chama*) *brassica* Reeve, 1847 (Bivalvia, Veneroida, Chamidae) - *Acropora dendrum* (Pl. XIV, Fig. 11)
· October 31, 1995. In a litter basket, in which useless organisms and stuffs caught in robster gill nets were gathered, at Sakai fishing port in Minabe Town facing to the northern mouth of Tanabe Bay.
· It is likely that this specimen was tangled in a lobster net set around the rocky reefs near Sakai fishing port. The shell was alive and the coral was partially dead.

33. *Chama* (*Chama*) *brassica* - *Acropora solitaryensis* (Pl. XIV, Fig. 12)
· March 4, 1998. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip net from a boat).
· This specimen seems to have been caught in a lobster gill net around Bansho-zaki Point

as mentioned in the case 1. Although the left valve was absent, a part of adductors remained inside the right valve when it was found. This suggests that when caught, it attached firmly to a rock. The coral, extending up to 58.4 mm outwards at the colony base from the margin of the balve, was wholly alive.

34. *Chama* (*Chama*) *brassica* - *Psammocora profundacella* Gardiner, 1898 (Siderastreidae) (Pl. XV, Fig. 1)
· April 16, 1998. Near the jetty of Ezura fishing port (Fig. 1), 1 m deep (with a dip net from a boat).
· The specimen seems to have been caught in a lobster gill net around Bansho-zaki Point as mentioned in the case 1. The shell was alive and the coral, extending up to 22.0 mm outwards at the colony base from the margin of the right valve, was wholly alive.

II. Specimens from coral reef regions

We examined six cases collected from southern coral reef regions; one case from Okinawa, one from Palau, and four from probably the Banda Sea and/or the Arafura Sea. In all cases, all the specimens were dead when they were examined and it is uncertain whether coral colonies colonized living shells or dead ones.

35. *Tridacna* (*Flodacna*) *maxima* (Röding, 1798) (Bivalvia, Veneroida, Tridacnidae) - *Porites* spp. (two species, one colony each) (Pl. XV, Fig. 2)
· April 2, 1997. On the shore of Iheya-jima I., Okinawa, stranded.
· One coral with large calices (1.1–1.3 mm in diameter) and another with smaller calices (0.7–0.9 mm in diameter) are seen on the left valve.

36. *Turbo* (*Lunatica*) *marmoratus* Linnaeus, 1758 (Gastropoda, Vetigastropoda, Turbinidae) - *Porites* sp.(Pl. XV, Figs. 3a & 3b)
· Palau.
· This specimen was found among the shell collections from Palau Islands collected before World War II, which are preserved in the Seto Marine Biological Laboratory, Kyoto University. A small coral colony (8.2 mm × 6.6 mm) with the calice size of 0.9–1.2 mm grew on the body whorl near the outer lip of the shell.

In the following four cases, well-grown shells which have never been found in the temperate zone of Japan were kept in Tanabe Senior High School, Wakayama Prefecture. Any labels were not attached to the specimens, but it is most likely that a button-making factory in Tanabe City donated these specimens to the school in 1948 or 1949. In those days, such factories in Japan imported large shells, e.g. *Tectus* and *Pinctada,* collected from tropical seas such as the Banda Sea and the Arafura Sea. It is likely that these specimens were collected from such seas.

37. *Tectus* (*Rochia*) *niloticus* (Linnaeus, 1767) (Gastropoda, Vetigastropoda, Trochidae) - *Pocillopora verrucosa* (Ellis & Solander, 1786) (one colony, Pocilloporidae), *Porites* spp. (three colonies of at least two species) (Pl. XV, Fig. 4)

38. *Tectus* (*Rochia*) *niloticus* - *Acropora* sp. (Pl. XV, Fig. 5)

39. *Tectus* (*Rochia*) *niloticus* - *Acropora* sp. (Pl. XV, Fig. 6)
· Several branches of the coral colony were lost.

40. *Pinctada maxima* (Jameson, 1901) (Bivalvia, Pterioida, Pteriidae) - *Turbinaria peltata* (Esper, 1794) (Dendrophylliidae) (Pl. XV, Fig. 7)
· The right valve was not remained.

Discussion

Various materials such as fragments of stony corals, shells, pebbles, slide glasses, plastic plates or dishes, concrete blocks and a variety of tiles have been used as settlement substrata for planula larvae for the study of the recruitment pattern and the growth of juvenile corals (Birkeland, 1977; Wallace & Bull, 1981; Babcock, 1985; Bagett & Bright, 1985; Harriott, 1985; Sato, 1985; Fitzerdinge, 1988; Gittings et al., 1988; Clark & Edwards, 1995; Misaki, 1995a, b; Banks & Harriott, 1996; Gleason, 1996). Larval settlement occurred on all of those experimental substrata. This fact indicates that larvae settle on any material if it is hard to some extent. Among them, fragments of corals, shells, ceramic tiles and pebbles are more suitable to deposit skeletons after metamorphosis than other materials (Lewis, 1974; Wallace, 1985; Harriott & Fisk, 1987; Misaki, 1988, 1995a). Thus, the calcareous surface of molluscs may be suitable for settlement of planula larvae, if the shell surface of living molluscs except infaunal species are not covered with attaching organisms which are regarded as spatial competitors of the corals, such as algae, sponges and bryozoans, and, in some species, with mantles, hairy periostracums, spines and nodules of molluscs themselves.

Forty-five coral colonies reported here belong to eight genera of six families out of 15 families of the Pacific hermatypic scleractinian corals, although most of the present colonies (32) belong to two genera of two major families, the Acroporidae and the Poritidae. On the other hand, 40 individuals of molluscs colonized by the corals consist of 15 genera in 12 families; six genera of the gastropods and nine genera of the bivalves. Figure 2 shows a wide variety of combinations in the association between corals and molluscs.

All the coral colonies growing on shells were less than 147.7 mm in the greatest length (Table 1). Despite most of such corals may not grow larger, some may reproduce because it is known that some hermatypic corals can sexually mature even in a small size, less than 7 to 8 cm in diameter (1.5 to 8 years old) such as *Stylophora pistillata* (Rinkevich and Loya, 1979), *Porites lutea* (Harriott, 1983), *Favia fragum* (Szmant-Froelich et al., 1985), *Acropora valida*, *A. granulosa*, *A. loripes*, *A. hyacinthus* (Wallace, 1985) and *Goniastrea aspera*, *G. favulus*, *Platygyra sinensis* (Babcock, 1988). Therefore, it is possible that the present association participates to some extent in the sexual reproduction of corals.

In the corals on large shells such as *Tridacna gigas* (Masuda et al. ed., 1986: a photograph in p.189) or on sessile bivalves such as oysters, it is conceivable that they can continue to grow, even beyond the valve edges to the rocky surface even though the bivalves die in the latter case. Furthermore, Nishihira (1997) reported that *Oulastrea crispata* (Faviidae) extended its habitat to the muddy bottom by colonizing the shells of *Strombus* (*Laevistrombus*) *canarium* (referred to as *Laevistrombus canarium turturella*) (Gastropoda, Neotaenioglossa, Strombidae). However, in most cases, shells may not be stable and sufficient substrata for continuous growth of corals. Primarily the surface area of the shell is limitted, and, moreover, molluscs must bear an extra load and resistence in water movements with the growth of corals. Especially, gastropods crawling on the reefs may lose the balance in movement and fall down onto the sandy bottom or may not right to their normal postures if the corals become large and heavy. In fact, during a culture of *Acropora valida* - *Astralium* (*Astralium*) *haematragum* (case 7) in an aquarium tank for five months, the shell lay down on the tank floor several times. In bivalves, 13 cases of *Hormomya mutabilis*

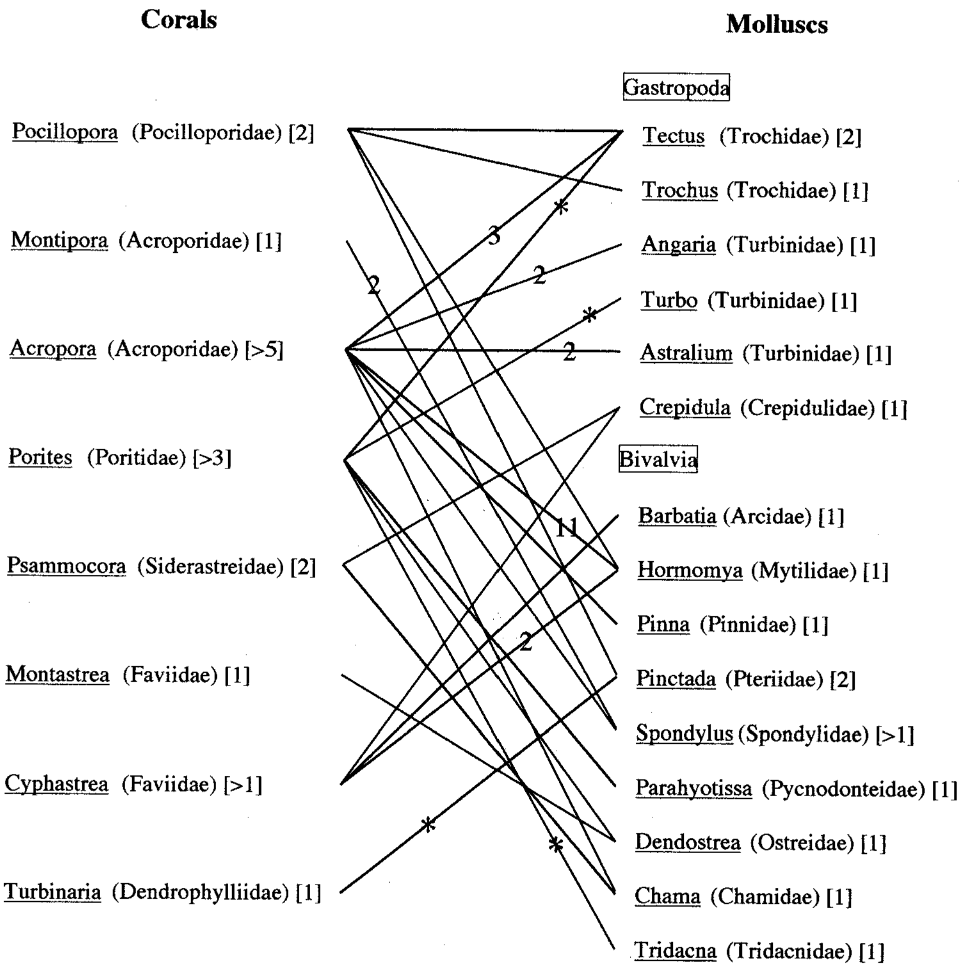

Fig. 2. Combination of genera between hermatypic scleractinian corals and molluscs colonized by those corals. Families are shown in parentheses, the number of species in brankets, and the number of cases (N$\geqq$2) and the combination found only in places other than Tanabe Bay (*) are on the lines.

(cases 11, 13–24) may show a typical pattern of fate in this relationship. Three shells (cases 15, 22 and 24) were alive in a *Hormomya* bed; eight (cases 11, 13, 14, 16–18, 20 and 21) were dead but still existed in their original positions among other living shells in the *Hormomya* bed; two (cases 19 and 23) were dead and lay down on the bottom. These findings indicate that the shells colonized by corals are killed owing to be covered by growing corals and thereafter detached out of their original positions by currents to lie down on the sandy bottom. Consequently, these "unstable footholds" (Nishihira, 1996) of shells might be one of the reasons why the corals growing on shells are not remarkable on the reefs.

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EXPLANATION OF PLATES XII-XV

All cases of the combination of molluscs and corals described in the text are shown.

Plate XII

Fig. 1. *Tectus (Tectus) pyramis - Acropora ?dendrum.* A photograph of the living specimen.
Fig. 2. *Trochus maculatus - Pocillopora damicornis.*
Figs. 3a & 3b. *Angaria neglecta - Acropora dendrum.* a: dorsal view; b: ventral view.
Figs. 4a & 4b. *Angaria neglecta - Acropora solitaryensis.* a: dorsal view; b: ventral view.
Fig. 5. *Astralium (Astralium) haematragum - Acropora hyacinthus.*
Fig. 6. *Astralium (Astralium) haematragum - Acropora hyacinthus.*
Fig. 7. *Astralium (Astralium) haematragum - Acropora valida.*
Figs. 8a & 8b. *Crepidula (Bostricapulus) grasvispinosus - Psammocora superficialis.* a: dorsal view; b: ventral view.
Fig. 9. *Crepidula (Bostricapulus) grasvispinosus - Cyphastrea* sp. Ventral view.

Plate XIII

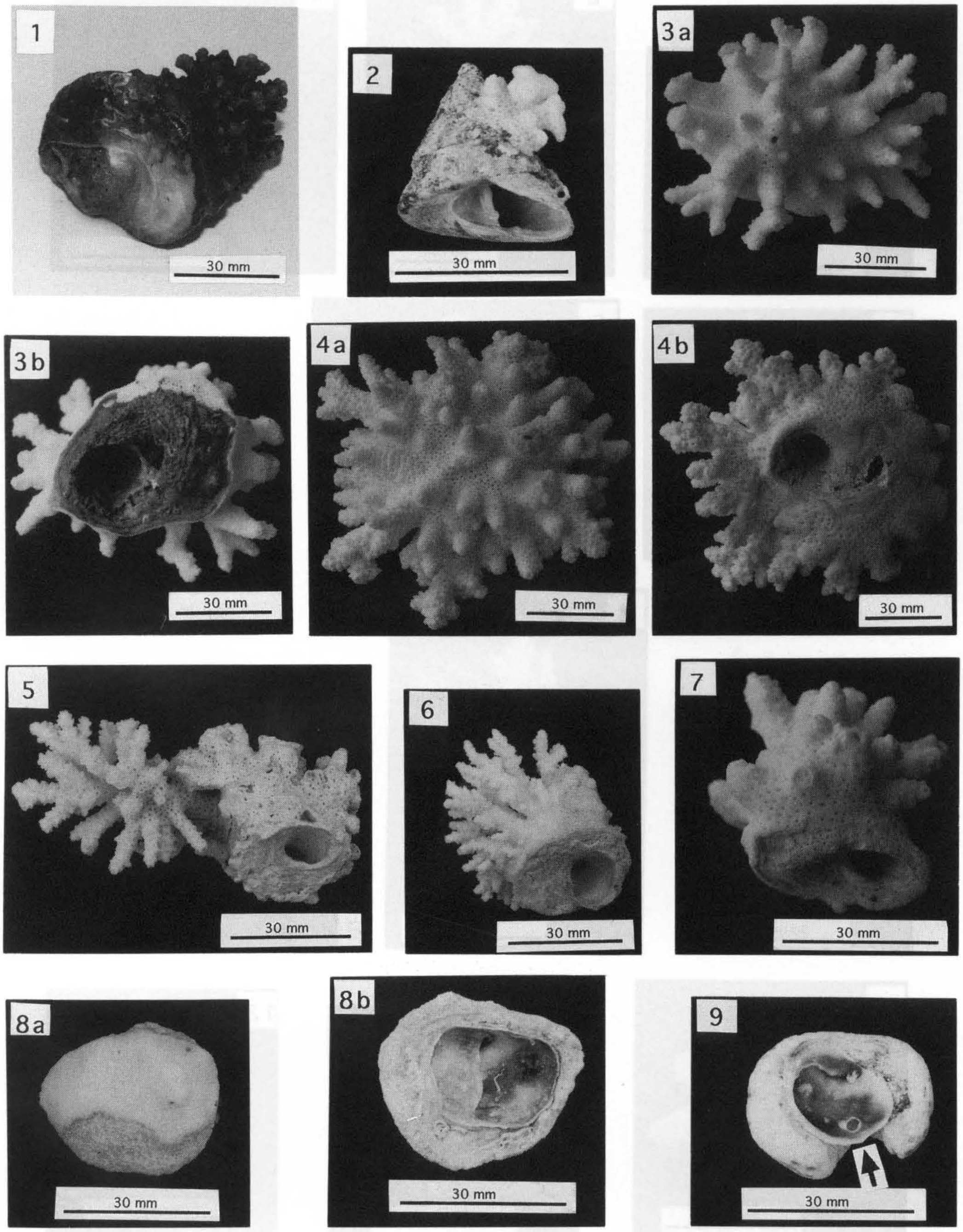
Fig. 1. *Barbatia (Abarbatia) lima - Cyphastrea serailia.*
Fig. 2. *Hormomya mutabilis - Pocillopora damicornis.* Ventral view.
Fig. 3. *Hormomya mutabilis - Acropora dendrum.* Ventral view.
Fig. 4. *Hormomya mutabilis - Acropora hyacinthus.* Ventral view.
Fig. 5. *Hormomya mutabilis - Acropora hyacinthus.* Ventral view.
Fig. 6. *Hormomya mutabilis - Acropora hyacinthus.*
Fig. 7. *Hormomya mutabilis - Acropora ?hyacinthus.*
Fig. 8. *Hormomya mutabilis - Acropora solitaryensis.*
Fig. 9. *Hormomya mutabilis - Acropora solitaryensis.*
Fig. 10. *Hormomya mutabilis - Acropora ?solitaryensis.*
Fig. 11. *Hormomya mutabilis - Acropora ?solitaryensis.*
Fig. 12. *Hormomya mutabilis - Acropora* sp.

Plate XIV

Fig. 1. *Hormomya mutabilis - Acropora* sp.
Fig. 2. *Hormomya mutabilis - Cyphastrea serailia.*
Fig. 3. *Hormomya mutabilis - Cyphastrea serailia.*
Fig. 4. *Pinna (Cryptopinna) bicolor - Acropora* sp. (arrow).
Fig. 5. *Pinctada margaritifera - Pocillopora damicornis* (arrow).
Fig. 6. *Spondylus (Spondylus) candidus - Acropora solitaryensis.* Inside view of the left valve.
Fig. 7. *Spondylus (Spondylus)* sp. - *Montipora* sp. Inside view of the valve fragment.
Fig. 8. *Parahyotissa imbricata - Porites* sp. (arrow).
Fig. 9. *Dendostrea crenulifera - Porites* sp. (arrows).
Fig. 10. *Dendostrea crenulifera - Montastrea valenciennesi.*
Fig. 11. *Chama (Chama) brassica - Acropora dendrum.*
Fig. 12. *Chama (Chama) brassica - Acropora solitaryensis.* Inside view of the right valve.

Plate XV

Fig. 1. *Chama (Chama) brassica - Psammocora profundacella.*
Fig. 2. *Tridacna (Flodacna) maxima - Porites* spp. (arrows).
Figs. 3a & 3b. *Turbo (Lunatica) marmoratus - Porites* sp. a: the shell and the coral colony (arrow); b: enlargement of the coral colony (arrow).
Fig. 4. *Tectus (Rochia) niloticus - Pocillopora verrucosa, Porites* spp. (arrows).
Fig. 5. *Tectus (Rochia) niloticus - Acropora* sp.
Fig. 6. *Tectus (Rochia) niloticus - Acropora* sp.
Fig. 7. *Pinctada maxima - Turbinaria peltata.*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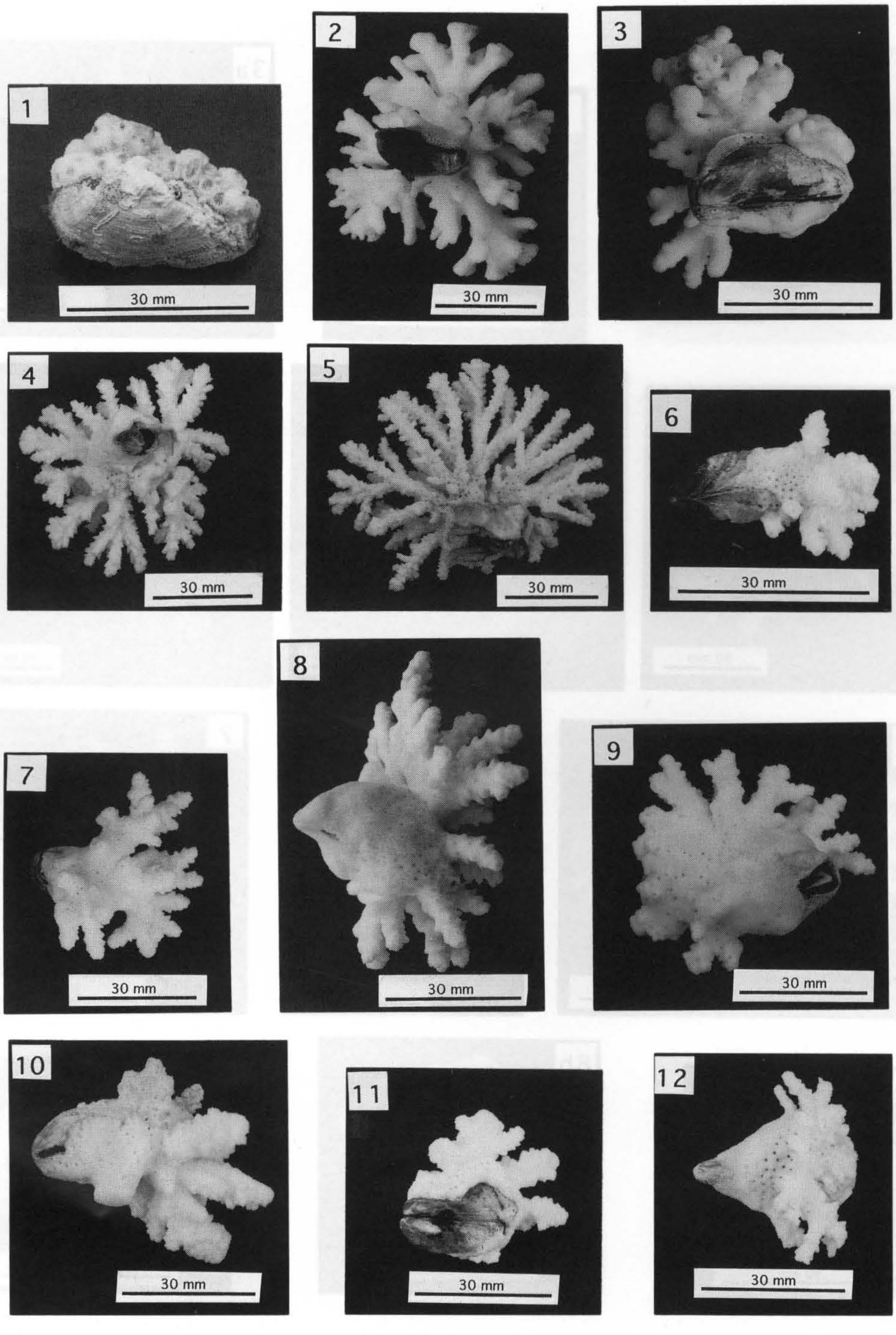
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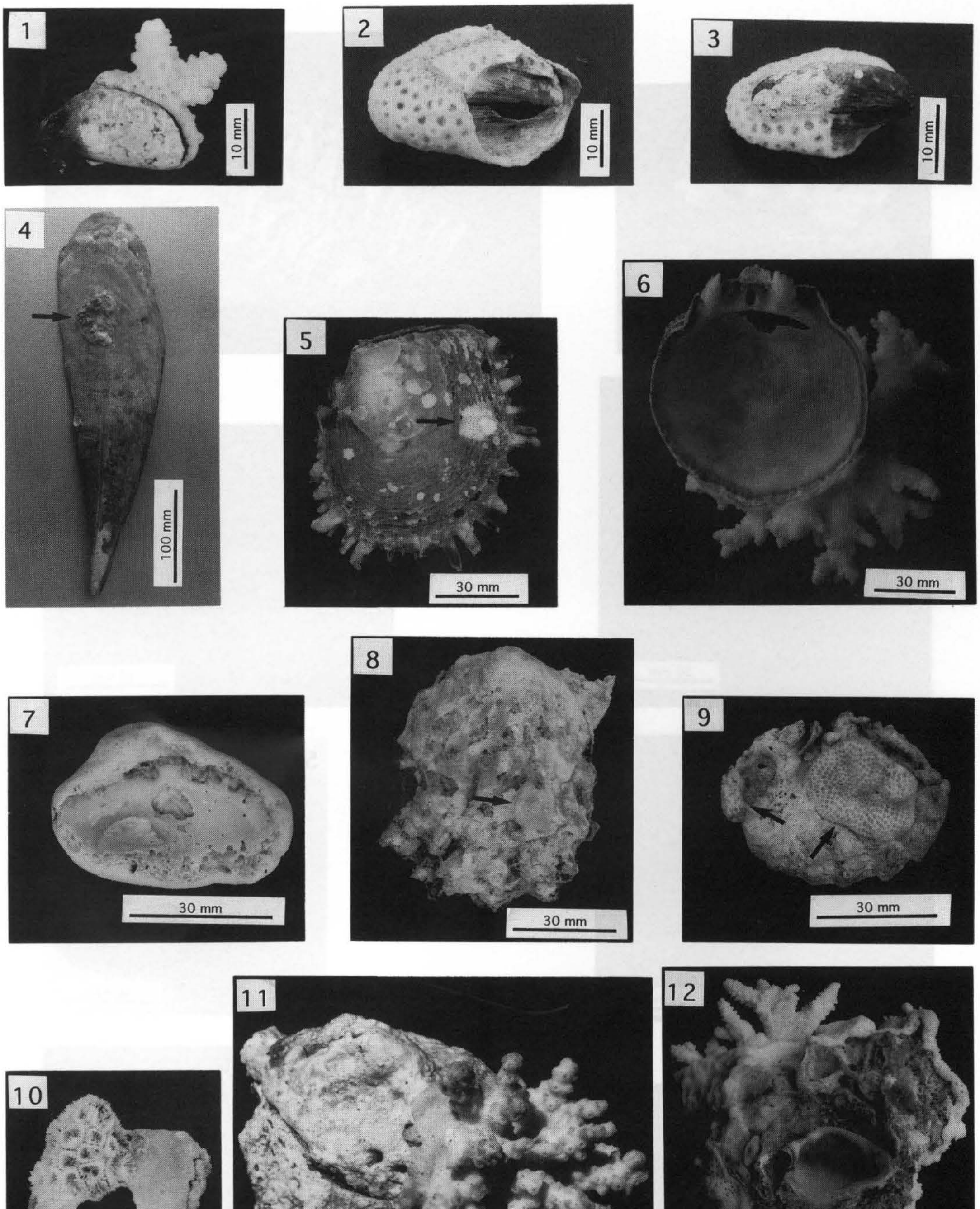
Plate XIV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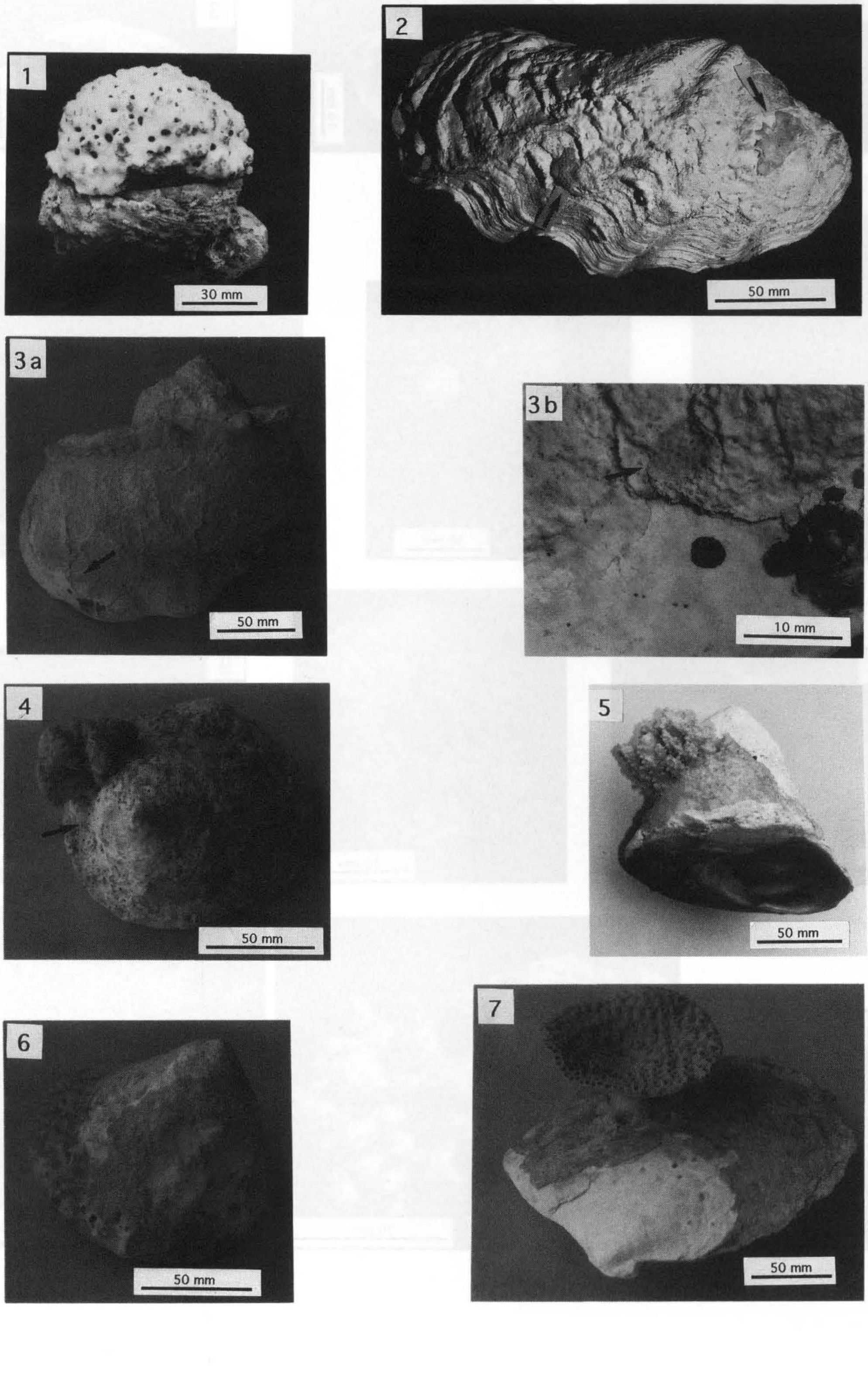
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